

MONTHLY WEATHER REVIEW,

APRIL, 1877.

WAR DEPARTMENT,

Office of the Chief Signal Officer,

DIVISION OF

TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE AND AGRICULTURE.

INTRODUCTION.

The present REVIEW for the month of April depends upon all data received up to the 15th of May from the Canadian Meteorological Service, the United States Signal Service and Voluntary Observers, the Army Post Surgeons and United States Navy. The most noticeable features recorded during the month are: the very severe storms off the Carolina coast from the 5th to the 14th; the general high temperature throughout the country; the excess of rain-fall in the South Atlantic States and Tennessee; the destructive hail-storms and tornadoes; the aurora of the 14th, visible from Dakota to Maine; the partial destruction of the grasshoppers west of the Mississippi by cold weather and snow, showing that the eastward migrations of these insects is probably limited by the vicissitudes of the climate of the Mississippi valley, whereby they are principally confined to the high, warm and dry plains that are not frequently visited by late cold weather and snows.

BAROMETRIC PRESSURE.

In General.—The general distribution of atmospheric pressure is shown by the isobars upon chart No. II, from which we see mean pressures of 30.00 or more reported from southern Florida, and from all Canadian stations. The area of lowest mean, 29.85 or less, extends from northern Texas to Nebraska. On the Pacific coast, 30.13 is reported from Portland, Or., and 30.01 from San Diego and San Francisco. Mean pressures east of the Rocky Mountains are from 0.05 to 0.20 less than during the cold months of April, 1874 and 1875, except in New Brunswick and Nova Scotia. In April, 1876, much higher pressures prevailed in the Southern States, and no marked area of high pressure appeared to exist north of the St. Lawrence and the Lakes.

Barometric Range.—The general range of the barometer over the whole country east of the Rocky Mountains was about 1.50 inches, as may be seen from the following table, which gives the maximum and minimum pressures that occur on the tri-daily maps, (7:35 a. m., 4:35 p. m. and 11 p. m., Washington time,) near the centres of the respective areas of high and low barometer:

AREA.	DATE.	LOW AREAS.	DATE.	HIGH AREAS.
No.		MINIMUM BAROM.		MAXIMUM BAROM.
I.	April 1st	29.28	April 1st	30.60
II.	" 5th	29.59	" 2d	30.57
III.	" 6th	29.26	" 8th	30.20
IV.	" 5th	29.70	" 9th	30.39
V.	" 8th	29.18	" 17th	30.24
VI.	" 13th	29.30	" 22d	30.45
VII.	" 18th	29.11	" 24th	30.37
VIII.	" 22d	29.70	" 30th	30.22
IX.	" 28th	29.40

The greatest local barometric ranges have been as follows: 1.37 in. at Leavenworth; 1.30 at Eastport; 1.27 at Duluth; 1.26 at Keokuk; 1.22 at Omaha; 1.21 at Yankton. The least local ranges have been: 0.39 at Pike's Peak; 0.72 at Cheyenne and Indianola, and 0.75 at Galveston.

Areas of High Pressure.—The areas of high pressure have presented no remarkable feature during the past month; they have extended somewhat to the north of their average position for this season; the average of the eight maximum pressures in the preceding table is 30.38, while the corresponding average for twelve areas during March was 30.40, showing but a slight change toward the conditions that prevail during the summer.

No. I—Is the same as No. XII of March, and was central over the Gulf of St. Lawrence on the morning of the 1st. It disappeared in advance of low barometer No. I.

No. II—Followed in the rear of low No. I, and was, on the 2nd, at 7:35 a. m., central in Minnesota; on the 3rd, 7:35 a. m., over Lake Huron; on the 4th, 7:35 a. m., over the mouth of the St. Lawrence.

No. III—Followed in the rear of low No. V, and was, on the 6th, at 7:35 a. m., north of Minnesota, whence it moved southeastward, and was, on the 7th, at 7:35 a. m., central over Lake Huron, and during the next 24 hours remained nearly stationary.

No. IV—Followed in the rear of low No. V, and was, on the 9th, at 7:35 a. m., central in Manitoba. During the next 24 hours, while extending southward, the eastward extension was also quite decided, and, on the 10th, 7:35 a. m., Nos. IV and III had united north of the Lake region, where cold, brisk northeast winds prevailed, while low area No. V continued near the South Atlantic coast. During the next 24 hours, while the pressure steadily increased in the Gulf States, Ohio valley and Northwest, the pressure also rose over the Lake region, with northeast winds, showing that here was the southern edge of a very extensive area of high pressure, which continued north of the Lake region until the 13th, 7:35 a. m., while the severe storm No. VI moved eastward over the Gulf States. During the 13th and 14th the pressure diminished over the Canadian stations, and the high pressure remained without definite limits.

No. V.—The passage eastward of low barometer No. VI was followed by southerly winds and rising barometer throughout the Gulf States, and the pressure remained high over Florida until the 18th, 7:35 a. m., after which it diminished, with southeast winds, while low No. VII moved eastward over the Ohio valley.

No. VI—Followed in the rear of low No. VII but preceded No. VIII, and was formed by the flow southward of the intervening region of cool, dry air. It was, on the 21st, at 7:35 a. m., central over Lake Michigan, but extended as a barometric ridge southward to the Gulf. It moved slowly southeastward; on the 23rd, at 7:35 a. m., it extended as a ridge from Georgia to the St. Lawrence valley; during the rest of this day the pressure rapidly fell at the northern extremity, and what remained was, on the 24th, at 7:35 a. m., central in the East Gulf States.

No. VII—Followed in the rear of low No. VIII, and, on the 24th, at 7:35 a. m., apparently extended as a ridge from Missouri northeastward to Manitoba; on the 25th, at 7:35 a. m., it extended over the Northwest and Lake region, and was central over Lake Michigan; on the 26th, 7:35 a. m., its southeastern extremity had covered the Middle States while the main body remained north of the Lake region, and was reinforced by an additional rise until low No. IX had reached the Missouri valley. On the 27th, 7:35 a. m., the area of high pressure evidently extended from the Lake region indefinitely to the northward. During the next 24 hours the pressure very generally fell over the Lakes and northward, but remained rather high over the St. Lawrence valley and Manitoba.

No. VIII—Followed in the rear of low No. IX, and appears to have been mainly due to the south-eastward flow of dry, cool air over the eastern slope of the Rocky mountains. It remained during the 29th and 30th central over the Southwest and Western Gulf States extending slowly eastward.

Areas of Low Pressure.—No. I.—The early history of this depression is given in the WEATHER REVIEW for March as area No. XII. It was central on the 1st of April, at 7:35 a. m., in western Minnesota, whence it moved nearly due eastward over the Lake region and Canada, and on reaching New England its nearly circular centre had changed to a rather long trough trending nearly north and south. The central pressure on the 1st, 7:35 a. m., was 29.28, but on the 2nd, 7:35 a. m., 29.92. The storm appears to have been broken up over New England, and was immediately followed by high barometer No. II. A tornado passed over Barry county, Missouri, about 5 p. m. of March 31st; it moved from the SW. to the NE., and its central portion was seen to be funnel-shaped, twisting spirally upward, and moving forward with great velocity. The central path of destructive winds was about 500 feet wide.

No. II.—This depression was central on the 2nd, 11 p. m., northwest of Dakota, having been preceded by a depression in Oregon; it moved eastward over the Lake region, being central on the 4th, 7:35 a. m., in northwestern Wisconsin on the 5th, 7:35 a. m., over Lake Huron. During the rest of this day this depression extended in all directions, and became merged into No. III, which was at that time moving northeastward along the Atlantic coast.

No. III.—An extensive area of cool northeasterly winds prevailed on the 3rd throughout the Gulf States, Ohio valley and Lower Lakes, followed during the afternoon and evening by increasing cloudiness and light rains. Some information in regard to the condition of the atmosphere is furnished by the observations made on the occasion of a balloon ascension at Nashville, the details of which are given in the accompanying diagram, from which, and other records, it appears that a gentle, moist current, at about the rate of four miles per hour from the NE., prevailed at the earth's surface over all the neighboring region. This current at Nashville prevailed up to altitudes varying between 2,500 and 3,100 feet above sea-level, or 2,000 and 2,600 above the Signal Service station. At these altitudes the balloon passed into a diametrically opposite cold and dry current, moving at the rate of 20 miles per hour, from the SW. The balloon ascended only about 5,200 feet, (barometer 25.50,) and the southwest current still existed at that height. Cirro-stratus clouds covered the heavens during the whole ascension, and were always above the balloon; this cloud stratum seems to have steadily increased from a haze in the morning to dense stratus at night, followed by rain at 11 p. m. The direction of its movement was from the SW., as observed at all the stations in Tennessee and Kentucky. The condition of the atmosphere at different levels is best seen by grouping the observations according to the altitudes at which they are taken. We thus obtain the following numbers:

STATIONS.	No. of Observations.	Time.	Barometer.	Thermometer.		Approximate altitude.	Ten. Vap.	Dew Point.	Relative Humidity.
				Dry.	Wet.				
I. In Balloon.....	10	P. M. 4:27	25.132	46.55	33.20	4,820	0.0450	-0.42	12
II. In Balloon.....	6	3:35	27.178	52.08	42.67	2,700	0.1600	+28.6	41
III. In Balloon.....	1	5:21	28.450	51.50	42.5	1,440	0.150	+28.9	42
	10	3:39	28.032	55.00	46.00	1,280	0.1805	32.8	44
IV. In Balloon.....	20	4:03	29.338	56.10	47.30	620	0.197	36.0	47
		{ 10 before. } { 10 after. }							
V. { Signal Service Station, } { Nashville. }	1	2:00	29.499	55.—	45.—	504.2	0.168	30.—	39
	1	3:56	29.462	57.—	46.—		0.166	30.—	36
	1	9:00	29.416	53.—	48.—		0.209	42.—	67
VI. *Reduced to sea-level.....	1	3:56	29.090			0			

The group II represents the temperature, pressure, &c., prevailing near the upper limit of the lower or warm, moist, gentle northeast current. Group I shows the conditions in the cold, dry and more rapid southwest current next above; the thickness of this strata we have no means of determining further than that the cirro-stratus clouds and haze, that at 5,200 feet were still above the balloon, were moving with it from the southwest, and, therefore, probably formed a part of it.

The general depression thus formed over so large an area was on the 4th, 7:35 a. m., central over northern Florida, whence the area of lowest pressure moved eastward to the Atlantic coast, after which it turned northeast, being central on the 5th, 7:35 a. m., off Cape Hatteras. During the rest of this day the barometer fell rapidly over New England and the storm-centre apparently turned northward in its course, being at 11 p. m., of the 5th, central near the coast of Maine, where it remained nearly stationary during the night. Its centre passed during the 6th very slowly over Maine and New Brunswick, and during the 7th equally slowly over Nova Scotia, east of which province it was central on the 7th, at 11 p. m.

Nos. IV and V.—The pressure fell rapidly at Manitoba between 4:35 and 11 p. m. of the 4th, and slightly in Oregon, where the barometer was quite high. The depression in Manitoba was rapidly followed by northwest winds and rising barometer, which latter extended rapidly southward into Kansas, where a new depression (No. V) was formed, during the 5th, between the areas of cold northerly and warm southerly winds. On the 5th, 4:35 p. m., No. IV was central north of the Lake region, while No. V was in Kansas. The former depression was now lost sight of, while the latter rapidly increased, after first moving southward into Texas, where it developed during the 6th and 7th. During the interval the extensive area of high pressure No. III moved southeastward over the Lake region and Middle States, followed by a decided depression, which rapidly stretched southward from Manitoba to Texas during the 7th, and seems to have led the way in the northward movement of area No. V, which was, on the 7th, 4:35 p. m., apparently central in Indian Territory, with a tendency to the formation of a new centre about 300 miles to the eastward. At 11 p. m. of 7th the lowest pressure was central in Mississippi, and undoubtedly represents the eastern division just referred to, whose development was attended by the tornado described further on. Its path is thence northward into Tennessee and eastward to the Carolina coast, where a slight depression existed on the 9th, 7:35 a. m., where the barometer remained low during the rest of the day, while brisk and high northeast winds prevailed along the Middle and East Atlantic coasts, and it seems likely that a well-defined, severe storm was developed at some distance off the coast, and moved northeastward, passing to the east of Nova Scotia at about 11 p. m. of 11th. At 4 p. m. of the 7th, while the centre of lowest pressure was in Indian Territory, a severe tornado passed over De Sota county, Louisiana. Later in the night another tornado

passed northward over Pensacola, Florida into Alabama, developing rapidly into a new area of low pressure. The destruction of property and life at Pensacola was severely felt; this storm began, with a strong SE. wind, at 2 p. m.; at 9 a. m. a very heavy rain began, partially ceasing at midnight; between 3 and 4 a. m. of the 8th the wind veered suddenly to a violent SW. gale, lasting only five minutes, but doing much damage. While the area of lowest pressure continued, during the 8th, west of the Blue Ridge mountains, the southward flow of air along the Atlantic coast produced violent gales on the North Carolina coast. At Cape Henry a wind of 65 miles per hour prevailed for 38 hours, and thence to Cape Hatteras, the storm is described as one of rare severity during the 8th and 9th. The schooner *Clara E. Bergen*, from Charleston for New York, encountered the gale of the 8th and hurricane of the 9th and 10th off Cape Hatteras, experiencing the highest winds at 8 a. m. of the 10th. The winds were from ENE. to SE.

No. VI.—The barometer began to fall in California on the 9th, and was lowest on the 10th, at 4:35 p. m. The subsequent depression at the Rocky Mountain stations continued into the 11th, the pressure being lowest at Santa Fe at 7:35 a. m. An area of low pressure was developed in Texas between the 11th, 4:35 p. m. and 12th, 7:35 a. m., and was, at the latter date, central in western Louisiana, but extended as a trough southeastward to Panama, where the pressure was 29.81, while it was about 29.70 at Aspinwall and 29.50 at Vera Cruz. By this time high northerly winds had swept down over Texas, and southeast winds, with rain, prevailed in the Eastern Gulf States. The area of lowest pressure moved thence southeastward into the Gulf of Mexico and then turning northeastward passed over Georgia to the coast of South Carolina. It was, on the 13th, at 11 p. m., central some distance east of the coast, whence it moved to the east-northeast beyond our stations. The U. S. S. *Powhatan*, was at 7:35, 14th, near its centre, with barometer 29.25, and a NNE. hurricane, being in latitude $34^{\circ} 20'$, longitude $76^{\circ} 25'$. In its passage over the South Atlantic States this storm developed into one of hurricane violence, and is described as such by vessels encountering it on the ocean. At Charleston on April 13th the wind increased from 2 a. m. to 5 a. m., when it had attained 36 miles per hour, and to a maximum, at 8 a. m., of 55 miles from northeast. This wind-velocity and the rain-fall of 6 inches between 3:30 and 8:20 a. m. has not been equalled before since the establishment of the Charleston station. The steamship *Gulf Stream* left Charleston, April 12th, 5:40 a. m., for New York. On Friday, April 13th, 4:30 a. m., when off Cape Lookout Shoals, the wind having become dangerous, the vessel steamed eastward; by 5 p. m. the wind had increased to a full hurricane velocity from the northeast, and the vessel, being about 100 miles off the coast scudded, before the wind receiving also considerable damage. The barometer continued at 29.30 and less from 5 p. m. of 13th to 2 a. m. of the 14th when the barometer had passed its lowest reading; the wind seems to have been due northeast. The steamers *G. W. Clyde*, from New York to Charleston, and *General Birney*, from Savannah for New York, encountered the same storm in about the same location.

No. VII.—The barometer fell rapidly during the 13th and 14th in Oregon, and a considerable depression was on the 14th, 4:35 p. m., apparently central in Manitoba, whence it extended southward without any definite existence as a storm-centre until the 16th, 4:35 p. m., by which time the pressure had begun to rise rapidly in Manitoba and Oregon, and the area of lowest barometer was probably central in southern Dakota. After moving southward into Nebraska and thence eastward to Iowa, the depression then began to extend north and south into an oval, which, on the 18th, was again contracted into a well-defined storm centre, which was, at 11 p. m. of 18th, central, with a very low pressure, in Western Missouri: tornadoes passed from Missouri eastward into Tennessee this night, and are reported from Union City, Laverne and Viola, Tenn. and Holly Spring, Miss. At this time the area of southwest winds and cloud or rain extended over the Eastern Gulf and South Atlantic States; southeast winds and rain in the Ohio valley and portions of the Missouri valley; northeast winds with rain over the Middle and Eastern States, Lake region and Upper Mississippi valley. These weather-conditions continued during the night, and greater part of the 19th, while the lowest pressure moved slowly eastward into the Ohio valley, where it was central on the 19th, at 11 p. m. The lowest isobars then began to stretch as a barometric trough along the line of the Alleghanies. On the 20th, at 4:35 p. m., the lowest pressure was central in Massachusetts, whence it moved northeastward along the coast of Maine and disappeared over the Gulf of St. Lawrence, on the morning of the 21st. At St. John, New Brunswick, on the 20th, a severe east gale prevailed in the early morning, proving very destructive to the shipping in the harbor.

Nos. VIII.—This depression follows immediately in the rear of high barometer No. VI, and is first well located on the 21st, 4:35 p. m., as a very long oval trending north and south through Dakota and Manitoba. The northwest winds in its rear closed in upon it by 4:35 p. m. of the 22nd, at which date an oval, central in northeastern Nebraska, represents what there was left of the original depression. This oval seems to have at once begun a rapid movement northeastward, and disappeared on the 23rd, 4:35 p. m., north of Lake Superior; meanwhile the cold northerly winds in their progress southward gave rise to a second depression in western Texas, which became merged into No. IX.

No. IX.—This depression appears to have originated in the precipitation that took place at the south-

western stations on the 24th. During this day the pressure fell on the Pacific coast and at all the Rocky Mountain stations, and an area of high pressure consequently moved southward over the Lake region and the Northwest, while southeasterly winds prevailed in the Gulf States. The area of precipitation extended, during the 25th, northward into Wyoming Territory and Nebraska, and on the 26th into Dakota, while the pressure continually fell in the Southwest, but rose north of Illinois and Iowa. On the 26th, 4:35 p. m., the lowest pressure was central in the southwestern part of Indian Territory, and severe hail-storms, with winds of tornado violence, occurred in Red river and Travis counties, Texas, during the evening. The storm-centre moved thence eastward and northward, and was, on the 27th, at 4:35 p. m., central from the southwestern corner of Nebraska to St. Louis, along the Missouri valley. The axis of the oval, which at this time trended east and west, so continued during the 28th, while the area of lowest pressure moved eastward into Ohio and thence northeast over the Lower Lake region. During the 29th two areas were formed, which were central, at 4:35 p. m., respectively, in northern Michigan and Pennsylvania—the latter moved southeastward to the Atlantic coast, and pressure remained very generally low over the Middle and Eastern States and Lower Lakes, with cloudy and rainy weather, but without any well-defined lowest pressure during the 29th and 30th.

Vessels experiencing storms at sea.—Besides the almost continuous gales that prevailed off the coast of the Carolinas and Virginia from the 5th to the 14th, the following notes relating to more distant storms have been received. On the 6th, lat. $29^{\circ} 40' N.$, long. $68^{\circ} 00' W.$, heavy SE to NE gale; 9th, $27^{\circ} 21'$, $75^{\circ} 03'$, heavy ENE to NNE gale; 9th to 13th, lat. 27° to 37° , long. 73° to 76° , heavy gale; 10th, lat. 35° to 34° , long. 71° , SE gale backing to NE; 11th, lat. 34° , long. 42° , strong W gale; 12th, off coast of Cuba, severe SE gale; 13th, lat. $42^{\circ} 13'$, long. $62^{\circ} 04'$, strong NW to N gale; 13th to 15th, lat. $24^{\circ} N.$, long. $73^{\circ} W.$, heavy WSW to WNW gale; 18th, lat. 36° , long. 67° , heavy SW gale.

TEMPERATURE OF THE AIR.

The general distribution of temperature is shown by the isotherms on Chart No. II. The comparison with the mean temperatures, observed at Signal Service Stations since 1870, is given in the small table upon the same chart, and shows temperatures above the average, excepting in the South Atlantic and Gulf States. The isotherm of 70° passes from Indianola, Tex., to the northern portion of the peninsula of Florida; its course is the same as in April, '76, but is $3^{\circ} N$ of its position in April, '75, and 2° to $3^{\circ} N$ of its position in April, '74; the isotherm of 40° passes through Bismarck, Duluth, Lake Huron, Quebec, Halifax, and its course is the same as in April, '76, but is $5^{\circ} N$ of its position in April, '75, and 5° to $7^{\circ} N$ of its position in April, '74. The following monthly means have been received since the chart was printed: Pembina, $33^{\circ}.1$, Virginia City, $36^{\circ}.5$, Fort Sully, $44^{\circ}.7$, and Cape Hatteras, $55^{\circ}.2$.

Maximum and Minimum Temperatures.—The maxima above 80° were: 91° at Indianola on the 7th. 88° Boerne, 4th. 87° San Antonio, 4th and 7th. 86° Tybee Island, 25th. 85° Augusta, 24th and 25th; Charleston, 24th; Jacksonville and Savannah, 20th; Wilmington, 24th. 84° Corsicana, 21st; Lynchburg, 24th. 83° Fort Gibson, 5th; Knoxville, 24th; Mobile, 28th; Norfolk and Shreveport, 6th. 82° Galveston, 20th; Louisville, 23rd; Montgomery, 25th; St. Mark's, 22nd; Washington, 24th. 81° Denison, 7th; Marquette and New York, 24th; St. Louis, 23rd; Vicksburg, 22nd. The maxima below 70° were: 68° at Barnegat, 25th; Wood's Holl, 24th. 66° Bismarck, 30th. 67° Breckenridge, 21st; Cheyenne, 20th; Santa Fe, 15th. 64° Buffalo, 23rd. 63° Duluth, 25th; Eastport, 23rd and 27th; Thatcher's Island, 26th. 61° Alpena, 20th and 22nd; Escanaba, 23rd. 49° Mount Washington, 24th. 26° Pike's Peak, 26th. The minima above 40° were: 42° at Augusta, 12th and 15th; Corsicana, 2nd; Savannah, 14th. 43° Charleston, 10th; Tybee Island, 14th. 45° Jacksonville and St. Mark's, 15th. 46° Montgomery, 5th. 47° San Antonio, —. 48° Shreveport, 2nd. 49° Mobile, 14th; Vicksburg, 3rd. 54° Galveston, 24th. 55° Indianola, 30th; New Orleans, 13th and 15th. The minima below 10° were: 9° at Cheyenne, 29th; St. Paul, 2nd. 5° Duluth, 2nd; Mt. Washington, 7th and 12th. 3° Breckenridge, 1st. 2° Bismarck, 2nd. -8° Pike's Peak, 29th.

Ranges of Temperature.—The largest diurnal ranges are as follows: 40° at Denver, 30th; 41° Boerne, 20th; 42° Leavenworth, 5th; 38° Cheyenne, 29th, Dodge City, 6th, Morgantown, 16th, Yankton 22nd; 39° Fort Gibson, 5th, Lynchburg, 24th, Marquette, —. The largest monthly ranges are: 60° at Denver; 61° La Crosse; 64° Bismarck, Breckenridge and St. Paul; 69° Marquette. The smallest monthly ranges are— 33° at Thatcher's Island; 34° Mobile and Pike's Peak; 35° Eastport and Shreveport; 36° Barnegat, Cape Lookout, Indianola, Montgomery and Wood's Holl; 25° New Orleans; 28° Galveston; 32° Vicksburg.

Frosts.—On the 2nd, in Ill., Tenn. 3rd, Ill., Md., Va. 7th, Md. 10th, Ark., N. C., Tex., Utah. 11th, Md., N. C., Va. 13th, Va. 14th, Ark., Va. 15th, Md., N. C., S. C., Va. 16th, N. C. 25th, Iowa. 26th, N. Y. 29th, Ill., Ind. Ty. 30th, Kan., Ark., Ill., Ind., Neb., Tenn., Ind. Ty., Mo.

Ice.—The occurrence of cold, dry nights, marked by the formation of ice rather than frost, is noted on the following dates: 4th, Utah; 9th, Utah; 11th, Va.; 12th, N. C.; 18th, 19th, 20th, 21st, 22nd, 23rd, Utah; 24th, Iowa, Utah; 27th and 28th, Utah; 29th, Kan., Neb.; 30th, Ill., Kan., Neb.

PRECIPITATION.

The general distribution of rain and snow is shown upon Chart No. III, from which it will be seen that the region of largest rain-fall covers Tennessee and the central Gulf States, with small areas of large rain-fall on the immediate South Atlantic coast. This latter feature is wanting in the rain-falls of 1874-'75-'76. An area of largest excess of rain over normal values is shown by the table on same chart to have been especially marked in the South Atlantic States and Tennessee, over which regions the precipitation has been two or threetimes its average value. A region of large rain-fall is also well marked throughout the Missouri valley.

Small Monthly Precipitations.—The total amount of rain and melted snow has been less than 0.5-inch at the following stations: Key West, 0.46; San Diego and San Francisco, 0.26; Maricopa Wells, 0.03; Wickenburg, 0.45; Brownsville, 0.13; Stockton, 0.09; Fort Bridger, Wyoming, 0.34; Camp McDermot, Nev., 0.20.

Large Monthly Precipitations.—The total amount of rain and melted snow has been 10 inches, or more, at the following stations: Cape Lookout, 10.65; Charleston, 15.00; Memphis, 13.90; Montgomery, 10.36; Carlsville, Ala., 15.10; Fayette, Miss., 10.30; Brookhaven, Miss., 12.00; Austin, Tenn., 10.70; Clarksville, Tex., 10.25.

Largest Special Rains or Snows.—Among the large special rains are the following; Vicksburg, 7th, 3.36; Fort Sully, 16th and 17th, 3.01; Denver, snow, 27th, 16 inches; Cape Lookout, 13th and 14th, 5.80; Charleston, 8th, 4.06, 13th, 8.30; Denison, 25th and 26th, 3.70; Green Springs, Ala., 7th, 4.75; Fort Gibson, 6th and 7th, 4.60; Galveston, 23d, 24th and 25th, 6.62; Grand Haven, 18th and 19th, 3.11; Leavenworth, 16th to 19th, 4.95; Memphis, 17th to 19th, 3.06, 24th to 27th, 4.43; Milwaukee, 18th and 19th, 4.55; Montgomery, 7th and 8th, 4.79, 27th and 28th, 3.01; Norfolk, 9th and 10th, 5.13; Genoa, Neb., 26th, 27th and 28th, 6 inches snow.

Hail-storms.—Besides numerous light hail-storms, severe ones are reported at Fort Larned, Kan., on the 22nd, Clarksville, Texas, 7th and 26th, Vicksburg, 7th, Austin, Texas, 26th. Morgantown, W. Va., on the 28th, from 5:15 to 5:19 p. m., occurred a fall of remarkably large hail; the largest hail measured 2 in. longest diameter and 1½ in. shortest; for two minutes preceding these large hail a smaller size fell, and for six minutes preceding, or beginning at 5 h 7 m., rain fell; the fall began with the wind SE., brisk backing to NW. at 5:26, and to W. at 5:45; the smaller-sized hail were generally round, with a nucleus of ice; of the largest size about one half had an ice nucleus, the remainder were composed of ice and snow. "A very noticeable feature on the larger stones was that when held in front, with the cone upwards, a twist or curve proceeded from the shoulders of the hail stone to the top of the cone from left to right," see the accompanying figure: the total precipitation during the storm was about 0.87 in. "Fifteen of the largest hail-stones were collected and melted, and gave 0.26 in. water in the gauge," which is equivalent to an average cubic contents for each hail-stone of 0.873 cubic inches.



Monthly Snow-fall.—The depth of snow-fall has been reported as follows: Golden, Col., 43.4 inches; Iowa, 4 to 12; Maine, 2 to 3; Mass., 2 to 3; Mich., 3 to 4; Neb., 2 to 6; N. H., 1 to 3; N. Y., 0.5; Vt., 1 to 7; Va., 0.5; Wis., 4 to 10.

Depth of snow on ground at close of month.—Iowa, 6 inches.

Rainy Days.—The number of days in which appreciable rain fell have averaged about as follows: New England coast and Middle Atlantic stations, 10 to 17; South Atlantic coast, 10 to 15; Gulf States, 9 to 16; Tennessee and the Ohio valley, 10 to 19; Lower Lake region, 8 to 14; Interior of New England, 7 to 10; Upper Lake region, 7 to 13; Upper Mississippi valley, 9 to 13; Lower Missouri valley, 14 to 19.

Cloudy Days.—The number of days on which the cloudiness has averaged eight-tenths or more, as reported principally by voluntary observers is as follows: New England, Middle Atlantic and South Atlantic States, Gulf States, Tennessee and Ohio valley, 7 to 16; Lake region, 11 to 17; Northwest, 6 to 13.

RELATIVE HUMIDITY.

The Relative Humidity averages on the coast of New England, 66 per cent.; Middle Atlantic States, 69; South Atlantic States, 71; Gulf States, 70; Tennessee and the Ohio valley, 63; Upper Mississippi valley, 62; Lower Missouri valley, 64; Upper Lake region, 67; Lower Lake region, 64; San Francisco, 68. At high stations, the averages uncorrected for the low pressures are Salt Lake City, 43; Santa Fe, 40; Pike's Peak, 87; Denver, 51; Cheyenne, 65; Mt. Washington, 64.

WINDS.

Prevailing Winds.—Are shown by the arrows upon Chart No. II. A somewhat unusual prevalence of N.E. winds is reported from most stations east of the Rocky Mountains, in which respect the past April offers a striking contrast to April of 1875 and 1876, and accords more nearly with April 1874. Westerly winds have prevailed as usual at the Rocky Mountain and Pacific coast stations, but east of the Rocky Mountains, they are reported only from Pembina, Fort Sully, Yankton and Memphis, N.W., Wilmington, S.W., at Pike's Peak, S.W., and at Mt. Washington, N.

Total Movements.—The largest total movements for the month are: Breckenridge, 10,080 miles; Cape May, 11,175; Cape Lookout, 12,734; Dodge City, 12,733; Indianola, 11,117; Kittyhawk, 12,118; Pike's Peak 14,341; Sandy Hook, 10,029. The smallest movements are: Augusta, 3,817; Lynchburg, 3,006; Nashville, 3,376; Baltimore, 4,264; Burlington, 4,361; Montgomery, 4,391; Shreveport, 4,327; Springfield, 4,375.

Highest Winds.—Wind-velocities of 50 miles or over are reported from Signal Service stations as follows: Atlantic City, 9th, N.E., 50; Breckenridge, 21st, N., 57; Cape Henry, — — 75; Cape Lookout, 10th, N., 68, 14th, N., 80, (the total movement was about 2,500 miles in 48 hours.) 28th, S.W., 56; Charleston, — — 55; Denver, 18th, — 60; Dodge City, 21st and 27th, — 60; Galveston, 24th, N., 72; Pike's Peak, 21st and 22nd, — 84; Smithville, 13th and 28th, — 50; Toledo, — — 58; Yankton, 1st, — 56; Mt. Washington, 6th, — 96; San Diego, W., 75.

Local Storms, Tornadoes, &c.—Local storms are reported as follows: On the 1st, at Pembina, Dak., a severe "blizzard" occurred, consisting of a northerly gale, with drifting snow and very low temperature, followed by clear, cold weather. On the 10th, at Santa Fe, a N.E. gale occurred, and a severe snow-storm, impeding travel. On the 18th a tornado was reported in southern Kansas, while at the Signal Service station at Leavenworth the barometer fell to 29.11, with high winds and heavy rains. On the same date tornadoes were reported in Missouri and central Tennessee. It is probable that these tornadoes were distinct from each other—their connection with storm No. VII is mentioned on a preceding page. At Fort Lyon, Col., there prevailed, during the day, a violent wind-storm from the N. On the 22nd the observer at Dodge City reports that, at 5:30 p. m., a strong whirlwind was seen approaching from the S.W.; the clouds above had also a rapid whirling motion; on reaching the river a waterspout was immediately formed, shooting rapidly upwards, with a sinuous motion, estimated to be about 600 feet high, with a diameter at base of 8 feet. At 5:45 p. m. the wind chopped around to the N., with heavy hail. On the 24th Galveston was visited, at 5:40 a. m., by a terrific thunder and wind-storm, accompanied by heavy hail, attending low barometer No. IX. The wind which was from the N. attained a velocity of 72 miles within 5 minutes of the commencement of the blow. A series of gales and local storms occurred in this neighborhood from the 23rd to the 29th. On the 26th a violent rain-storm occurred at Memphis, and severe local storms in Indian Territory and Texas.

VERIFICATIONS.

Indications.—The detailed comparison of the tri-daily weather "Indications" with the telegraphic weather reports for the succeeding twenty-four hours shows a percentage of omissions 0.6. The general average percentage is 85.7 per cent. Out of 3,580 predictions, 2,640, or 73.7 per cent, have been fully verified; 236, or 6.6 per cent, have been three-fourths verified; 459, or 12.8 per cent, have been half verified; 86, or 2.4 per cent, have been one-fourth verified; 159, or 4.4 per cent, have failed. The percentages for the four elements have been: Weather, 91.6; Wind, 85.3; Temperature, 82.6; Barometer, 83.3. The percentages by geographical districts have been: New England, 82.3; Middle Atlantic States, 84.8; South Atlantic States, 86.1; East Gulf States, 86.4; West Gulf States, 88.0; Lower Lakes, 85.8; Upper Lakes, 86.1; Tennessee and Ohio valley, 88.1; Upper Mississippi valley, 84.9; Lower Missouri valley, 85.0.

Cautionary Signals.—During the month 156 Cautionary Signals have been ordered for stations on the Gulf and Atlantic coasts and the Lakes. Of these, 117, or 75 per cent, were justified by subsequent high winds within one hundred miles of the station where they were displayed, and 39, or 25 per cent, were not justified so far as known. Seventy-one instances of high winds, when no signals were displayed, have also been reported from these stations during the month. Telegraphic communication with Cape Lookout was interrupted during the entire month.

NAVIGATION.

Stage of Water.—In the table on chart No. III is shown the highest and lowest readings of river-gauges, with the respective dates. At the close of the month the Red river and the lower Mississippi were from 8 to 11 feet higher than at the beginning. The upper Mississippi was 3 feet higher. The upper Missouri was several feet lower. At other river stations the water has fluctuated irregularly during the month.

Opening of Navigation.—The following reports have been received relative to ice in rivers and harbors

and the opening of navigation: Duluth, first boat left 29th. Chicago, 3rd, ice disappeared from harbor. Milwaukee, 25th, first vessel arrived from the Lower Lakes, being five days out from Cleveland. Marquette, 15th, ice in bay. Escanaba, 18th, ice moving out of Green Bay; 21st, ice moved from docks. Ice clearing out of the Straits of Mackinaw, 13th. Alpena, 20th, first vessel arrived. Northport, Mich., 20th, ice left harbor; 22nd, first boat. Port Huron, 23rd, first steamer arrived from Detroit, but much ice remained, and on the 30th forty vessels were still ice-bound. Detroit, 12th, navigation opened, first vessel arrived. Toledo, 19th, first boat arrived from Alpena; 22nd, first vessel left. Cleveland, 10th, navigation open to Detroit. Erie, 21st, navigation opened; Lake clear of ice 24th. Buffalo, 7th, harbor free from ice, and first vessel left 14th; on 27th, first vessel arrived from Toledo. Rochester, 6th, first vessel arrived. Oswego, 19th, first vessel arrived. Bismarck, 1st, ice-gorge; 10th, navigation opened. Omaha, 6th, floating ice. St. Paul, 2nd, ice moving down in large quantities; 16th, navigation opened. Moorhead, Minn., 7th, Red River of the North began rising; 15th, ice moving; 20th, first boat arrived. Pembina, 18th, ice breaking; 23rd, first steamer arrived. West Waterville, Me., 17th, ice cleared from Snow pond. Lake Village, N. H., 22nd, ice went out of Lake Winnepississee. West Charlotte, Vt., 2nd, Lake Champlain clear of ice. Lunenburg, Vt., 10th, ice went out of Connecticut river. Geneva, Wis., 12th, Geneva Lake clear of ice. Neillsville, Wis., 3rd, ice broke up in Black river; 22nd, river clear. Norfolk, Va., 9th, highest water since 1846. Charleston and Savannah, 13th, were flooded by high tide. Indianola, 24th and 25th, town flooded by high tide.

TEMPERATURE OF WATER.

The temperature of the water is shown by the table on chart No. II. It will be noticed that along the *Atlantic coast* the temperatures have increased very uniformly from 34° to 31° at Eastport to 81° and 69° at Key West. On the *Gulf coast* they have ranged from 60° to 71°. On the *Lakes*, the somewhat abnormal maxima of 60° and 61° are reported at Grand Haven and Toledo, but for the rest of the Lake stations the range is from 33° to 51°. The average temperature for the Upper Lakes is apparently 1° or 2° lower than for the Lower Lakes.

River Temperatures.—In the Missouri, temperatures from 34° to 60°; in the Ohio, from 43° to 58°; in the Tennessee and Cumberland rivers, 53° to 61°; in the Mississippi, 33° to 61°.

Ocean Water, Temperatures and Densities.—According to the meteorological observations made on board of the Pacific Mail Steamship Alaska on her voyage from San Francisco to Yokohama, November 1st to 30th, 1876, the specific gravity, reduced to a uniform temperature of 60°, of the water observed at noon each day, at 18½ feet below the surface, was as follows: 4, from Nov. 1st at San Francisco to the 12th at long. 160° W. of Greenwich; 5, from Nov. 13th at long. 163° W. to Nov. 17th at long. 177½° W.; 4.5, Nov. 19th long. 179° E. to Nov. 21st long. 174° E.; 5, Nov. 22nd long. 170° E. to Nov. 30 at Yokohama long. 140°.

ATMOSPHERIC ELECTRICITY.

Thunder-storms occurred as follows: 1st, Ala., Ill., Ind., La., Mich., Miss., Ohio, Penn., Tenn., Tex., Wis.; 2nd, Dak., N. C., Fla., Ga.; 3rd, Miss., Fla., Ala.; 4th, Ill., Ind.; 5th, Kan., Miss., Penn., Tex., Ind. Ty.; 6th, Ala., Ga., Ill., Kan., Minn., Miss., N. C., Ohio, Tenn., Tex., Ind. La.; 7th, Ala., Dak., Col., Fla., Ga., Kan., La., Miss., N. C., S. C., Tenn., Tex., Minn., Ind. Ty.; 8th, Fla., Ga., Miss., N. C., S. C.; 9th, Ga., N. C., Tex.; 11th, Tex.; 12th, Fla., Ga., La., Miss., Tex.; 13th, Ga., Ohio, S. C.; 14th, Dak., Kan., Minn.; 15th, Iowa, Kan., Wis., Ill.; 16th, Dak., Col., Ill., Ind., Iowa, Kan., Minn., Neb., Ohio, Penn., Ind. Ty., W. Va.; 17th, Dak., Conn., Ill., Iowa, Kan., Minn., Mo., Neb., N. J., N. Y., Ohio, Tenn., Tex., Va., Wis., Ind. Ty., W. Va., D. C.; 18th, Ala., Ill., Ind., Iowa, Kan., La., Neb., N. C., Ohio, Penn., Tenn., Tex., N. J., Ind. Ty., Ky.; 19th, Del., Ill., Ind., Md., Mo., N. J., N. Y., N. C., Ohio, Penn., Tenn., Va., S. C., Fla., Ky., W. Va., Ga., D. C.; 20th, Canada, Conn., Fla., Mass., N. J., N. Y., Va., Ohio, Ga.; 21st, Dak., Minn.; 22nd, Dak., Kan., Minn., Neb., Ohio, Ind. Ty.; 23rd, Ill., Iowa, Kan., La., Mich., Minn., Mo., Miss., Neb., Ohio, S. C., Tex., Wis., Ind. Ty.; 24th, Ind., Kan., Md., Ohio, Penn., Tex., N. Y., Ky., N. Mex., D. C., Canada; 25th, Tex.; 26th, Ala., Ind., Kan., Tenn., Tex., Ind. Ty.; 27th, Ala., Ill., Ind., La., Miss., N. C., Ohio, Tex., Iowa, Mo.; 28th, Ala., Fla., Ga., Ind., Ky., La., Md., Mich., N. J., N. Y., N. C., Ohio, Penn., W. Va., Canada; 29th, Conn., Del., Ga., Md., Mass., N. J., N. Y., N. C., Penn., S. C., Va., Fla., D. C.; 30th, Conn., Del., Fla., Me., N. Y., N. J., N. C., Mass.

Auroras are reported as follows: 5th, Duluth and Pembina; 7th, observed at 24 stations as follows: in Mich., 4; Mass., 3; Dak., 2; N. Y., 9; Conn., 1; Me., 2; N. H., 1; N. J., 1; Vt., 1; Canada, 1. 8th, Buffalo and Rochester, N. Y.; Port Auron, Mich. 9th, Gardiner, Me.; Canonsburg, Penn.; Mt. Forest, Canada. 12th, Boston, Mass. 13th, Lunenburg, Vt.; Wautoma, Wis. 14th, observed at 76 stations as follows: Mich., 7; N. J., 6; Me., 9; Mass., 8; N. Y., 15; Vt., 5; Penn., 3; Dak., 1; N. H., 4; W. Va., 1; Wis., 3; Conn., 3; D. C., 1; Ill., 2; Ind., 1; Iowa, 3; Ohio, 1; Va., 2; Canada, 1. 15th, Palermo and New York City, 16th, Fort Preble, Me.; Mystic, Conn. 28th, Vevay, Ind.; Monticello, Iowa.

Telegraphic Ground Currents are reported by the observers as follows: Santa Fe, on the 2d, 10th, 24th, 25th and 26th; Pike's Peak, on the 6th.

OPTICAL PHENOMENA.

Solar Halos.—1st, Ohio, Dak., Ga. 2nd, Dak., Miss., Tenn., Wis. 3rd, Ill., N. Y., Ohio, Mich., S. C. 4th, Me., N. H., N. Y., Tex., Mich. 5th, N. Y., Dak. 6th, Iowa, N. Y. 7th, Fla., Ill., Md., Mich., Neb., Ohio, Ind., S. C. 8th, Del., Md., Mich., N. J. 9th, Iowa, Mass., Mich., N. Y., Conn., Minn. 10th, Iowa, La., Miss., Ohio, Tex., Mich., Minn., Mon. 11th, Ill., Iowa, Mich., N. Y., Wis., Ind., Minn. 12th, Iowa, Mich., Wis., S. C., Minn., Kan., N. C. 13th, Ill., Ind., N. J., N. Y., Ohio, Penn., Wy., Col., Tex., Conn. 14th, Iowa, Me., Md., Mo., Neb., N. H., N. Y., Conn., R. I. 15th, Iowa, N. H., Mich., Wy. 16th, Ind., Me., N. H., N. Y., Ohio, R. I., La. 17th, Ga., Me., Mich., Ohio, Wis., N. J., S. C., Ky., Ala. 18th, Ill., N. Y., Ga. 21st, Ark., Ind. Ty. 22nd, N. J., Tenn. 23rd, Conn., Del., Ill., Mass., N. J., N. Y., Tenn., R. I. 24th, Ill., Ky., N. Y., Ala. 25th, Ill., Iowa, Mass., Ohio, Vt. 26th, Ill., Ind., N. J., N. Y., Ohio, Penn., S. C. 27th, Conn., Me., Mass., Mich., N. H., N. Y., Ohio, Vt., S. C., R. I. 28th, Me., N. H. 29th, Iowa, Tenn. 30th, Tenn., Tex.

Lunar Halos.—1st, Ohio, N. C. 3rd, Ind. 16th, Mass. 17th, Dak., N. Mex. 18th, Dak., S. C., Minn., N. Mex. 19th, N. J., Ohio, Minn., Dak., Minn., N. C. 20th, Del., Kan., Mass., Mo., N. J., Tex., Minn., N. C. 21st, Fla., N. J., N. Y., Ind. Ty., Kan., Ga., N. C., La. 22nd, Fla., Iowa, Kan., Mo., N. J., N. Y., Mich., La., Conn., N. C. 23rd, Conn., Ill., Iowa, Mich., Mass., Minn., Ohio, Ind., Tenn., Ala., Fla. 24th, Iowa, Kan., Ky., Neb., N. H., N. J., N. Y., N. C., Ohio, Dak., Minn., Col., Me., Ind., Fla., R. I., Ga., Conn. 25th, Ill., Ind., Ohio, Wis., Iowa, S. C., Va., N. C., W. Va., La., Minn. 26th, Conn., Ind., Mass., N. Y., Ga., Minn., Ill., Me., R. I., Ohio. 27th, Ky., Me., N. H. Ohio, Tenn., Minn., Ga. 28th, Ind. 29th, Tenn. 30th, Tenn.

Mirage.—Fort Pembina, Dak., 2nd; Duluth, Minn., 7th, 21st; Marquette, Mich., 19th; Atlantic City, N. J., 24th.

Scintillation of Stars.—No observations of scintillation have been received for April.

MISCELLANEOUS PHENOMENA.

Zoo'logical.—**BOTANICAL**.—The blooming of flowers and trees have been reported as follows: *Anemones*, 17th, Mass. *Dandelions*, 19th, Mass. *Apricots* in bloom, 1st, Md.; 15th, Kan.; 16th, N. J.; 26th, Penn. *Apple trees* in bloom, 15th, Ind.; (first bloom;) 20th, Ohio; 22nd, W. Va.; 26th, Ohio; 28th, Ill.; 30th, Mo., (full bloom;) Ind. *Blackberries*, 16th, La., (ripe.) *Crab Apples* in bloom, 29th, Kan. *Currents*, 20th, Ohio. *Cherry* in bloom, 4th, Va.; 8th, Md.; 15th, Kan.; 20th, Ill.; 22nd, Md., N. J.; 23rd, Kan.; 24th, W. Va.; 25th, N. J.; 26th, N. Y.; 27th, N. J.; 28th, N. Y.; 29th, Ohio; 30th, Mo., Ohio, Ind. *Fever Bush* in bloom, 25th, Mass. *Magnolias* in bloom, 23rd, Mass., (full bloom.) *Maples* in bloom, 20th, Mass., (red maple.) *Peach* in bloom, 4th, Ill.; 6th, Kan.; 8th, Md.; 14th, Ky.; 15th, Kan.; 17th, Md., N. J.; 21st, Neb., (full bloom;) 22nd, Ill.; 23rd, Neb.; 24th, N. J., Ohio; 26th, N. Y., Penn.; 30th, Ind. *Pear trees* in bloom, 4th, Va.; 12th, N. J.; 16th, N. J.; 19th, Ind., (full bloom,) Ohio; 23rd, N. J.; 26th, Ohio, Penn.; 30th, Mo., N. J., Ohio, Ind. *Plum* in bloom, 12th, Kan.; 13th, Kan.; 15th, Kan.; 17th, Md.; 19th, Ill.; 20th, Ill., Ohio; 21st, Neb.; 22nd, Neb.; 24th, W. Va.; 26th, Ohio. *Strawberries* in bloom, 4th, Ill.; 16th, N. J.; 26th, Ohio. *Willow trees* in bloom, 19th, Mass. *Violets* in bloom, 17th, Mass., (Dogtooth;) 26th, Mass., (blue.)

BIRDS.—The first arrival and their migrations are reported as follows: *Bluebirds*, 1st, Wis.; 3rd, Wis.; 4th, Ohio; 12th, Minn.; 24th, Utah. *Blackbirds*, 1st, Somerset, Mass., (first seen,) N. H., Wis.; 2nd, Vt.; 3rd, Me., flying N., Wis.; 4th, Iowa, N. Y.; 10th, Iowa; 12th, Minn., N. H., N. Y.; 14th, Vt.; 22nd, Dak.; 26th, Utah. *Catbirds*, 23rd, Va. *Cranes*, 1st, Wis., N.; 4th, Iowa, N.; 10th, Iowa, N. *Ducks*, 1st, N. Y.; 4th, Iowa, N.; 10th, Dak., N. *Wild geese*, 1st, Iowa, S., N. Y. Wis.; 2nd, Kan., NE., Mass., SE., Conn., N.; 3rd, Me., N., Mt. Desert, Me., (first seen,) N. H., N., Mass., N.; 4th, Iowa, N., Me., N., Md., NW.; 8th, Iowa, N., Conn., N.; 9th, Minn., N.; 10th, Me., NE., Dak., N.; 11th, Dak., S. and N., Me., NE.; 13th, Dak., N., Mass., SE.; 14th, Dak., N., Mass., N. and E.; 15th, Conn., E.; 16th, Dak., N.; 17th, Conn., N., Mass., N., N. J., NW.; 19th, Dak., N.; 20th, N. J., N.; 21st, Md., N.; 24th, Mass., N. *Hawks*, 8th, Dak., N. *Kill-dee*, 19th, N. Y. *Larks*, 1st, N. Y.; 2nd, Mass., N. Y.; 3rd, Wis.; 4th, N. Y.; 6th, Ohio; 12th, N. H.; 14th, N. Y.; 24th, Utah. *Martins*, 1st, Md., (first seen,) Penn.; 2nd, Kan.; 4th, W. Va.; 7th, Mo.; 10th, Md.; 13th, Ohio; 14th, Mass.; 16th, Wis.; 17th, N. J.; 23rd, N. C., Wis.; 24th, Ind., N. Y.; 28th, N. H. *Mocking birds*, 4th, Fla., (singing;) 7th, Kan.; 10th, Ill.; 15th, Va. *Oriole*, 13th, Vt. *Prairie chickens*, 4th, Iowa. *Pigeons*, 19th, Ohio; 25th, Iowa. *Peewees or Phebe birds*, 2nd, N. Y.; 3rd, Neb., Wis.; 4th, N. Y.; 9th, N. H.; 12th, Ohio; 14th, Vt. *Robins*, 1st, Mass., Wis., Me.; 2nd, N. H., N. Y.; 3rd, Vt., Wis.; 4th, Vt.; 5th, Ohio; 7th, Minn.; 8th, Mich.; 9th, N. Y., Dak.; 11th, Wis.; 17th, Me.; 19th, Creswell, Kan., (first one seen in six years;) 24th, Utah. *Suipes*, 1st, N. Y.; 10th, Ill. *Sparrows*, 4th, Vt.; 7th, Me., Ohio, Vt.; 8th, Vt.; 9th, N. H.; 12th, Wis.; 14th, N. Y. *Swallows*, 6th, Miss.; 10th, Kan., Mass.; 11th, Mass.; 12th, N. Y.; 15th, Ohio; 17th, Ill.,

N. J.; 18th, N. Y., Wis.; 20th, Wis.; 21st, N. Mex., (first seen,) Mass., Neb., Wis.; 22nd, Penn.; 23rd, Penn., Wis.; 24th, Iowa, Mass., N. C., Vt.; 25th, N. H.; 26th, N. Y., Penn.; 27th, Me., Ohio; 28th, Conn. *Thrush*, 6th, Mass.; 17th, Ohio. *Whip-poor-will*, 1st Fla.; 15th, Va.; 20th, Ill., Neb.; 21st, Iowa; 22nd, Ind., N. C.; 23rd, Md. *Woodpeckers*, 8th, W. Va.

FISHES.—*Shad*, 11th, Ardenia, N. Y., (first caught.) 13th, Flushing, N. Y., (first caught,) and numerous on the 18th.

INSECTS.—*Grasshoppers*, 7th, at Macon, Ga., blown thither by storm winds. 10th, Howard, Neb., first eggs hatched; Denison, Iowa, hatching during month; at Tabor, Iowa, but few hatched out. 13th, Fort Gibson, Ind. Ty., numerous; Corning, Mo., those hatched in February have disappeared. 23rd, Denison, Tex., first appeared. 30th, Creswell, Kan., nearly all gone; Corsicana, Texas, very numerous, corn and wheat damaged. *Colorado Beetle*, or *Potato Bug*, 9th, Wappinger's Falls, N. Y.

Polar Bands.—N. H., Auburn, 1st, 4th, 16th. Miss., Brookhaven, 2nd. Iowa, Tabor, 5th, 18th; Iowa City, 10th, 14th, 16th, 24th; Muscatine, 24th. S. C., Charleston, 6th. Ohio, Carthagena, 6th, 7th, 9th, 10th, 12th, 23rd. Ga., Tybee Island, 7th. Va., Wytheville, 7th, 9th, 15th. N. J., Vineland, 8th, Freehold, 22nd. La., Point Pleasant, 10th. Minn., Duluth, 14th, 29th. N. Y., Waterburg and Flushing, 14th; Malone, 24th. Me., Gardiner, 24th, 28th.

Prairie and Forest Fires.—Fort Randall, Dak., 1st, 3rd, 12th; Bismarck, Dak., 14th, 15th, 20th, 21st, 23rd; Monticello, Iowa, 8th; Creswell, Kan., 3rd, 4th, 5th, 6th, 7th, 10th, 13th, 19th, 20th, 29th; near Fall River, Mass., 22nd, raging for three days; St. Paul, Minn., 8th; Genoa, Neb., 15th; Eastport, Me., 27th; Wytheville, Va., 6th, 24th; Morgantown, W. Va., 13th, 14th; Embarrass, Wis., 13th, 22nd; near Scranton, Penn., 15th; Barnegat, N. J., 24th, 25th; Denison, Tex., 10th.

Meteors.—Iowa: Davenport, 1st; Monticello, 20th. Dak.: Yankton, 4th. N. Y.: Wappinger's Falls, 9th, 10th; Flushing, 10th; Vermillion, 11th; Waterburg, 13th; Cooperstown, 15th. N. H.: Contoocookville, 12th; Auburn, 14th, 21st. Ind.: Vevay, 12th, 13th, 14th. Wis.: Wautoma, 13th. N. J.: Vineland, 14th. Ind.: Bloomington, 15th. D. C.: Washington, 22nd. Ohio: Jacksonburg, 25th. Va.: Wytheville, 27th. Vt. Woodstock, 30th.

Sunsets.—The characteristics of the sky, as indicative of approaching fair or foul weather, have been observed daily at sunset at all Signal Service stations. The monthly summaries from 88 stations show that 98 doubtful cases and blanks were recorded, and that out of the remaining 2,542 cases 2,108, or 82.8 per cent., have been followed by the expected weather.

Zodiacal Light.—Conn., Colebrook, 7th, 9th, 12th. Ga., Savannah, 5th, 6th, 14th. Iowa, Monticello, 1st, 2nd, 4th, 5th, 6th, 7th, 15th, 29th, 30th. Ohio, Bellefontaine, 5th, 9th, 12th. Me., Cornish, 11th. Mass., Somerset, 6th; Fall River, 3rd; Cambridge, 3rd, 6th, 9th, 12th. N. J., Atco, 5th, 6th, 7th, 10th, 12th, 14th, 15th. N. Y., Waterburg, 2nd, 6th, 7th, 9th, 10th, 11th, 12th, 13th, 14th; North Argyle, 9th. Va., Wytheville, 5th, 6th, 14th, 29th.

Earthquakes.—Panama, 17th, slight shock of short duration, 5:50 a. m. Auburn, N. H., 23rd, slight shock from NW. to SE., at 11 a. m. A slight shock was felt at Franklin, N. C., at 5 p. m. of 26th.

NOTES AND EXTRACTS.

In the Paris Comptes Rendus des Academie des Sciences de Paris, for March 12, 1877, and in the Bulletin International de l'Observatoire de Paris, for March 20th, M. de Crova gives some measures showing the variations of the solar heat as received at the earth's surface. Observations were taken on January 4th and July 11th, 1876, continuously throughout these remarkably clear and quiet days. The following are the results of his calculations:

Total amount of heat received at Paris upon one square centimeter.	JANUARY 4, 1876.		JULY 11, 1876.	
	Normally to sun's rays.	Upon a horizontal surface.	Normally to sun's rays.	Upon a horizontal surface.
	Calories.	Calories.	Calories.	Calories.
1st. Total from sunrise to noon.....	264.4	78.9	451.5	293.5
2nd. Total from noon to sunset.....	270.6	82.3	424.9	280.6
3rd. Total from sunset to sunrise.....	935.0	161.2	876.4	571.1
During the hours of sunshine the heat received in one minute varied from. §	0 to 1.29	0 to 0.53	0 to 1.21	0 to 1.16
The ratios of the total amounts of heat received daily upon normal and horizontal surfaces. §	$\frac{161}{533} = 0.301$		$\frac{571}{876} = 0.653$	
The ratios of the heat received on these two days are.....	Normally..... §		$\frac{535}{876} = 0.610$	
	Horizontally. §		$\frac{161}{571} = 0.281$	

In Poggendorff's *Annalen*, 1877, No. 1, page 31, Haga gives a further contribution to our knowledge of the absorption of the radiant heat by aqueous vapor. He shows that of the heat that emanates from a plate covered with lampblack and heated to 212° Fahr., probably 0.86 of 1 per cent. is absorbed in passing through a column of aqueous vapor 0.951 feet long at a temperature of 62° 6 or 64° 4 Fahr.; also 0.61 of 1 per cent. is absorbed in passing through a column of vapor 0.623 feet long at the same temperature; whence it follows that for a column of vapor 3,281 feet long at 62° 6 or 64° 4 Fahr., the absorption would be 3.1 per cent., and for a column 10,827 feet long the absorption is 10 per cent. In these experiments the heat rays had first passed through a small extent of the atmosphere of the room. Assuming that rays of all wave lengths are absorbed with equal facility we can now compute the absorption by a column, at any other temperature, and of any other length, and, consequently, that due to the moisture contained in the atmosphere at any time.

In a memoir by Leonardo de Tejada, on the hurricane of the 13th of September, 1876, the central track, as it passed over the West Indies, is charted as passing over the northern edge of St. Kitt's, then about 5 miles north of Santa Cruz, then directly through the centre of Porto Rico from Yabucoa on its southeast coast to Rincon at its northwest extremity, thence through the central portion of Hayti and the eastern half of Cuba. The greatest severity of the winds occurred at St. Kitt's on the 12th, 8:30 p. m.; at San Juan, 13th, 8:30 a. m.; at Yabucoa, 13th, 7 a. m.; at Rincon, 13th, 11:30 a. m.; at Porto Platte, Hayti, 13th, 8:30 p. m. In moving over the interior of the Island of Hayti its average hourly velocity was approximately 21.7 miles. The greatest hourly velocity of winds observed at San Juan, de Porto Rico, was from 62 to 80 miles. This storm is the same as that numbered VII in the Signal Service Weather Review for September, according to which, its central track lay a little to the east of Florida; it passed centrally over Wilmington on the 17th, at 8 a. m., and over Washington, at 5 p. m.

In the *Bulletino Meteorologico dell Osservatoire del Collegio Romano*, for March, is given the mean daily velocity of the wind as observed at Rome from 1862 to 1876. The annual periodicity is well shown by the following monthly means:

MONTH.	MEAN.	MONTH.	MEAN.
	Miles Daily.		Miles Daily.
January	124.5	July	130.3
February	106.2	August	124.0
March	140.4	September	110.0
April	117.2	October	115.5
May	120.9	November	123.1
June	122.4	December	127.2
		Annual	122.6

From the Appendix to the *Bulletin des Observatoire de Zi-Ka-Wei, China*, we compile the following table, based on four years of observations, 1873-'76, inclusive:

Zi-Ka-Wei, latitude 31° 12', long- itude, 76. 56m. east of Paris; altitude 23 feet.	Pressure.	Temperature in shade, Fahrenheit.			Force of vapor.	Relative humidity.	Cloudiness.	Number of rainy days.	Rain-fall.	Prevailing winds.
	Inches.	Mean.	Max.	Min.	Inches.	Per ct.			Inches.	
January.....	30.350	39° 4	69.1	16.5	0.173	82	6.2	8.2	2.28	NW
February.....	30.250	40° 3	77.9	18.9	0.197	78	6.5	9.7	2.56	NE
March.....	30.155	47° 1	78.6	29.8	0.264	78	6.6	14.0	3.19	NE
April.....	29.995	57° 7	88.7	32.7	0.366	75	5.5	9.2	2.16	SE
May.....	29.801	67° 3	99.3	37.4	0.508	77	6.4	9.5	1.93	SE
June.....	29.749	72° 9	107.7	35.4	0.697	83	7.4	14.8	10.12	SE
July.....	29.686	81° 7	102.0	66.0	0.878	81	5.4	8.0	1.69	SE
August.....	29.741	80° 4	98.2	62.2	0.854	82	5.5	9.5	4.76	SE
September.....	29.895	73° 4	95.5	44.2	0.673	81	5.8	9.2	5.65	NE
October.....	30.107	63° 3	84.2	39.0	0.457	78	5.7	8.2	3.76	NE
November.....	30.239	50° 7	78.1	26.4	0.295	74	5.9	4.5	0.70	NW
December.....	30.286	43° 0	70.0	17.2	0.220	78	4.3	4.5	1.12	NW
Year.....	30.026	59° 4	102.0	16.5	0.461	79	5.7	109.5	39.25	

For the same important station the following wind-roses are given for the years 1875-'76:

Wind-direction.	Mean Pressure.	Mean Temperature.	Force of vapor.	Relative Humidity.
	<i>Inches.</i>	<i>Fahrenheit.</i>	<i>Inches.</i>	<i>Per cent.</i>
N	30.036	59°.9	0.429	80.4
NE	30.028	59°.2	0.455	79.5
E	30.019	59°.8	0.483	80.7
SE	30.004	60°.8	0.485	73.5
S	29.963	62°.7	0.492	73.4
SW	29.940	63°.0	0.478	70.9
W	29.940	60°.4	0.457	74.0
NW	29.997	57°.7	0.412	78.1
N	30.006	56°.9	0.429	80.4
Average 1875 and 1876	29.991	60°.0	0.461	77.0

In the Resume for 1876 of the Commission de Meteorologie de la Haute Savoie, occurs the following passage relative to the thunder-storms of this Department of France. "Our thunder-storms ordinarily come from the southwest, but as often we see them follow the courses of the valleys without regard to the compass bearings; they are preceded by mists, rarely by cirri, then by clouds which generally grow denser and lower. At the same time the atmosphere is charged with electricity, and the fall of the barometer is irregular and saltatory * * * * The occurrence of thunder-storms is subject to too many unknown circumstances to justify the risk of predicting them. There are some zones of thunder-storms which cover several departments, so that when the lightning starts at any point, the thunder-storms burst simultaneously over the whole area, and it is then already too late to send a telegraphic warning; at other times, on the contrary, the storm is dissipated before it matures."

In the Monatliche Übersicht der Witterung, January, 1877, der Deutsche Seewarte, the following items are given as the principal characteristics of the weather of Central Europe during January:

1. The large variations of barometric pressure, especially in the second half of the month (28.66 to 30.71 inches;) the monthly mean pressure was however near the normal value.

2. The large number of barometric minima which pursued their way through Central Europe; the most notable were those of the first and last days of the month.

3. The stormy weather attending these areas of low pressure, especially the great storms of the 1st and 2nd, and the 30th and 31st; on every day of the month, at one or more stations, a wind force was observed of 8, 9 or 10 of the Beaufort Scale, and during the 1st to 7th, and the 25th to 31st, storm winds prevailed over large areas.

4. The flood wave in East Friesland, accompanying the storm of 30th and 31st, (the highest of the century, except that of 1825); and the overflow in West Prussia, due to the extensive and long continued stoppage by ice.

5. The extraordinary high temperature, especially in the first half of the month, the excess of the monthly means above the normal values, ranges from +35.2 F., for the Baltic Provinces to +40.6 F., for Wurtemberg, +40.6 F., for Central Austria, +37.9 F., for Switzerland.

6. The large precipitation, which amounted to twice its usual amount in the Netherlands and some portions of Hanover and Lausitz.

The verifications of the predictions, published by the Hamburg Seewarte, for January, which was an unusually unfavorable month, are announced as follows:

Month.	Weather. Per cent.	Wind. Per cent.	Temperature. Per cent.	Average.
Well verified.....	68	67	70	68
Partly verified.....	22	21	25	22
Not verified.....	10	12	5	10

In the Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie for 15th of March, Von Obermayer gives a clear presentation of the arguments for and against the existence of hollow vesicles of vapor in clouds, fogs, &c., and shows that we have reason to believe that such vesicles cannot possibly exist, and that all known phenomena are well explained as due to extremely small solid drops.

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Albert J. Myer

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Brig. Gen. (Bvt. Assg^d.) Chief Signal Officer, U. S. A.